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Energy and Nutritional Value of Raw Grains of Domestic Bean Varieties

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Abstract

Beans are food with high nutritional value. In the history of human diet beans are found in use very early, and availability throughout the year enables its wide application. In Bosnia and Herzegovina beans are common ingredients which are an integral part of a meal, especially during the winter. The aim of this paper is to give contribution to the selection of local varieties of beans by highlighting energy and nutritional value of raw grains. The tests in this study included three local varieties of beans, namely Bosna, Darko and Igman in order to assess the levels of carbohydrate, protein and fat (energy content) and the content of minerals (copper, iron, phosphorus, manganese and magnesium). Test results indicate that content of dry matter and water is not conditioned by varietal differences, but the total fat content varies from 0.84% (Bosna) to 1.73% (Darko), and total sugar of 2.4% (Bosna) to 3.36% (Darko and Igman). Protein content compared to the dry matter ranged from 21.18% (Darko) to 25.28% in Bosna. Starch content ranged from 65.78% (Igman) to 67.04% (Bosna). The tested varieties of beans contained significant amounts of trace elements, thus in 100g raw grains there is: up to 69.7% of magnesium, up to 59.2% of phosphorus, up to 79.8% of manganese, up to 42.2% iron and up to 64.1% copper of the RDA (Recommended Dietary Allowances - the total daily needs).

Key words: beans, raw grain, energy content, minerals, RDA

Introduction

Many researches deal with bean growing and aim at achieving high yields. Creation of local varieties provides significant advantages because genetic potential of varieties is used, those that have acquired properties resulting from adaptation to

environmental conditions. It takes time to get varieties that are more tolerant to climatic and soil factors and with adequate cultivation practices, resistant to diseases, whilst reaching stable yields and recognizable aspect of the products with nutritional value. Beans are traditionally acceptable food in the diet, but there is no acquired habit to perform selection based on knowledge of the nutritional and energy properties. Tendencies of European legislation are based on the improvement of informing consumers about the nutritional properties of products. Consumers need information about the recommended servings (serving size), the energy value (calories) as well as chemical composition and quantity of certain nutritive substances in the product such as proteins, carbohydrates, fat and contents of some micronutrients. Regarding the previous states, there is need to further analyse the contents of macro-and microelements in raw grains of local varieties of beans, Bosna, Darko and Igman, selected in the Federal Institute of Agriculture in Sarajevo, and the obtained values show the energy and nutritional indicators.

Materials and methods

The material used is a dry grain of three local varieties of beans: Bosna, Darko and Igman grown on the Butmir site during the growing season of 2011. Bosna and Igman belong to *Phaseolus vulgaris* L. Bosna variety is low with white flowers, flat medium large pods and colourful beans - Bordeaux with pink beige spots. The absolute grain weight is about 540g. Darko belongs to *Phaseolus multiflorus* Lam (syn. *Phaseolus coccineus* L.). This is a high variety that needs support for its cultivation. Clusters have red flowers, large flat green beans and black beans with purple spots. The absolute mass of grains is aprox. 1300g. This variety is intended primarily for preparation of salads as well as for various stews. Boiled beans have a distinctive chestnut flavour, which can be acceptable particularly for traditional dishes with beans of recognizable Bosnian-Herzegovinian quality (Ćota et al., 2006). Igman is a low variety but it does not need a support to grow. Clusters have white flowers, large flat green beans and white beans. The absolute mass of grains is about 890 g.

Energy and nutritive value of raw bean seeds of local varieties was determined on the basis of the content of carbohydrates, proteins and fat (energy content) and content of minerals (copper, iron, phosphorus, manganese and magnesium). In laboratory analyses, standard methods were used:

- Moisture content - drying at 130°C;
- Total protein - Kjeldahl;
- Fats in relation to dry matter - Soxhlet;
- The content of total sugars - titrimetry and
- Contents of trace elements: EN 13805:2002, EN 15763:2009 and ETC, ETC method.

The amount of energy carried by the studied cultivars was determined on the basis of the energy value of nutrients keeping in mind that 1 kcal = 4.186 (kJ) and 1 gram of protein provides 4.2 kcal of energy, 1 gram of carbohydrate provides 4.2 kcal

of energy, 1 gram of fat provides 9.45 kcal of energy (Rulebook on labelling nutritional value of packed food products, “Official Gazette BiH”, number 85/08).

Results and discussion

In recent times, vegetables are the subject of many scientific studies which confirm their versatile nutritional value. Nutritionists divide dietary (nutritional) components in vegetables into two basic groups:

- Macronutrients: water, carbohydrates, proteins and fats, and
- Micronutrients (phytochemicals): vitamins, enzymes, minerals and flavouring materials, pigments, pectins, tannic substances, and others.

Some authors, giving information about the nutritional value of vegetables to consumers, divided them into nutritious, those that give smaller amount of proteins, a significant amount of carbohydrates and insignificant amount of fat, and non-nutritious, which contain only slight, almost negligible amounts of these macro-elements. The nutritious vegetables are the ones that contain about 5 g of carbohydrates, 2 g of proteins, meaning 25 kcal (105 kJ) in 100 g (Mandić, 2007).

Legumes are the best and largest source of vegetable proteins in diet and a meal with cereals or their products has high content of proteins that can be compared with meat or dairy products. Thus, if the goal is to eliminate red meat from the diet, it can be replaced by such a meal. It is known that the composition of proteins from edible plants is deficient in some essential amino acids, and the favourable combination of foods of plant origin in the diet can be achieved by adequate intake of amino acids. Beans are one of the foods that have been isolated as food with favourable combination of proteins (Stojisavljević et al., 2004).

Useful indicators for understanding the study of local bean varieties (Bosna, Darko and Igman) was given in the study of chemical composition of five varieties of domestic beans in Serbia (Varieties: Sremac, Belko, 20, Zlatko, Balkan). The results of chemical composition of these varieties of beans give the following average values: total sugars with the content ranging from 5.80% to 7.57%, starch content from 51.00% to 53.71%, oil 0.71 to 1.02%, protein from 21.90% to 23.75% (Tepić et al., 2007). According to some indicators, nutrient contents listed in the previous survey and the results of this study have approximate values. Many studies emphasise high calorific value of beans. According to USDA data (2007), energy and nutritional value of 100g bean seeds is 1393 kJ, with a total of 23.56 g of proteins, total carbohydrates at 60.01 g, and total fat content at 0.83 g.

Test results in this paper indicate that the content of dry matter and water is not conditioned by varietal differences (Table 1), but the total fat content varies from 0.84% (Bosna) to 1.73% (Igman). The total fat content in the grains of Darko variety (1.73%) is above the average value (USDA, 2007) by 0.89%. The content of total sugars in the grain varies ranges from 2.4% in cv. Bosna up to 3.36% for Darko and Igman varieties.

Tab. 1. The results of chemical analysis of the content of individual nutrients in dry bean seed and energy value in 100g

Rezultati hemijske analize sadržaja pojedinih nutrienata u suhom zrnu graha i energetska vrijednost u 100g

Contents <i>Sadržaj</i>	Bosna %	Darko %	Igman %
Total fat <i>Ukupno masti</i>	0.84	1.34	1.73
Total sugar <i>Ukupno šećera</i>	2.40	3.35	3.36
Proteins <i>Proteini</i>	25.28	21.18	22.45
Starch <i>Škrob</i>	67.04	66.04	65.78
Water <i>Voda</i>	13.6	13.51	13.23
Energy value in 100g <i>Energetska vrijednost u 100g</i>	526.92 kJ 125.45 Kcal	532.64 kJ 126.8 Kcal	537.28 kJ 120.35 Kcal

The results of chemical analysis of samples of local bean varieties indicate that the total protein content ranges from 21.18% in the dry grains of Darko to 25.28% in cv Bosna. By total protein content (22.45%), dry bean Igman is behind Darko variety. According to these values, Bosna has the highest quality because the average protein contents exceed prescribed content (USDA, 2007) by 1 g in 100 g of grains, whereas in Igman (by 1.11 g) and Darko (by 2.38 g), these values are lower.

A certain proportion of starch in relation to grain dry matter was 65.78% for Igman, 66.04% for Darko, and 67.04% for Bosna. Calculated energy values of the tested varieties were significantly lower compared with the data provided by the USDA (2007). For Bosna, it was 526.92 kJ, 532.64 for Darko and 537.28 kJ for Igman. According to the data of authors about Igman, the protein contents were 22.45%, 5.70% cellulose, 4.80% sugars, 2.80% fat and 3.79% ash, being specific for this variety (Ćota et al. 2007) that by its protein content coincides with the results of these studies but other parameters are not in line, which indicates that the influence of a growing season is very strong. Similar results were obtained for Darko and Bosna (25.28% protein content, 4.10% cellulose, 6.0580% sugars, 2.35% fats and 3.31% ash). Work of Vukašinović et al. (2007) points to the different protein contents.

Mineral content in the grain of domestic dry bean cultivars is the added value when wanting to know their contents and highlights it as a positive nutritional property. Minerals are inorganic substances that occur naturally in soil and water, and hence reach plants. Many minerals are essential substances, i.e. substances which compose human (and animal) organisms and must enter through food or drink from the outside. Taking them with food and drinks, they reach the human body in much larger amounts than vitamins. The research by Tepić et al. (2011) presents data about the mineral content in the beans, which shows that beans are rich in potassium (732.24 to 1527.26

g), magnesium (151.87 to 186.70 g) and calcium (130.31 to 215.28 g). There is also copper (0.64 to 0.90 g / 100 g), zinc (2.44 to 3.35 g), manganese (1.40 to 2.10 g), iron (5.09 to 6.46 g) and sodium (43.42 to 96.35 g), and the phosphorus in beans is to a large extent present in the form of phytic acid.

World Health Organization (WHO) and national legislation of each country determine the daily needs of the individual macro-and microelements. The minerals examined in this paper, their average daily requirements are as follows: copper 1.5-3 mg, phosphorus 800 mg, magnesium 350 mg, manganese 2.5-5 mg, and for iron 10 mg. The tests for iron content in the dry grain in the domestic varieties of this study indicate that the daily needs for iron are up to 42.2% RDA, or up to 60% compared with the WHO recommendations.

Tab. 2. Contents of some microelements in the grain dry domestic varieties of beans
Sadržaj nekih mikroelemenata u suhom zrnu domaćih sorti graha

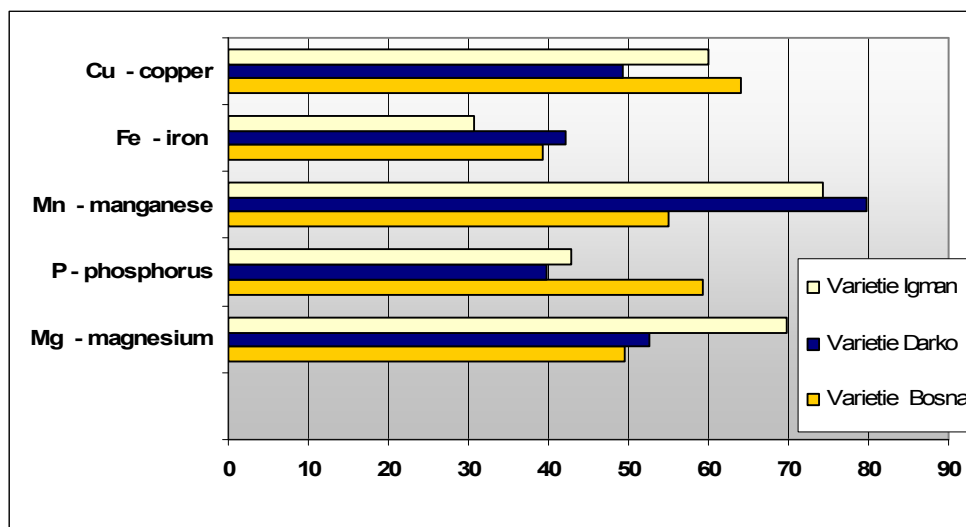
Microelements <i>Mikroelementi</i>	Bosna mg/ 100g	Darko mg/ 100g	Igman mg/ 100g	RDA* mg
Mg Magnesium	147.8498 (49.6% RDA)	156.7679 (52.6% RDA)	207.6750 (69.7% RDA)	298.0
P Phosphorus	472.4484 (59.2% RDA)	316.9850 (39.7% RDA)	341.9875 (42.8% RDA)	798.0
Mn Manganese	1.0988 (54.9% RDA)	1.5956 (79.8% RDA)	1.4808 (74.4% RDA)	2.0
Fe Iron	5.6659 (39.3% RDA)	6.0718 (42.2% RDA)	4.4009 (30.6% RDA)	14.4
Cu Copper	0.5277 (64.1% RDA)	0.4443 (49.2% RDA)	0.5409 (60.1% RDA)	0.90

*Energy and nutritional values in 100 g

*Energetske i nutritivne vrijednosti u 100g

When analysing the obtained information of the content of individual minerals for each tested cultivar separately (Table 2), there are obvious differences of minerals by species and varieties. Igman has the highest content of magnesium (207.6750 mg) in 100 g of dry beans, Bosna has the most phosphorus (472.4484 mg) and copper (0.5277 mg), whereas the domestic variety Darko has the highest content of manganese (1.5956 mg) and iron (6.0718 mg). These differences between varieties are relatively high and significant if we consider them in terms of their replacement with other sources. In support to this, the data obtained on magnesium content in the dry grain variety Igman compared to Bosna differs in the entire 20.1% in favour of the first variety, then 13.5% phosphorus and 14.9% copper in favour of Bosna variety (in relation to Darko), and 19.9% manganese and 11.6% iron in Darko (in relation to Igman). Bearing in mind that bean cultivars contain significant amounts of trace elements and comparing them with the recommended average quantity RDA, it can be stated what quantity of these significant nutrients can be taken in the body from 100g of raw grains of domestic bean varieties (Table 2).

The average for all cultivars, the recommended daily allowances - RDA for magnesium were met by 69.7%, up to 59.2% for phosphorus, up to 79.8% for manganese, up to 42.2% for iron and up to 64.1% for copper (RDA = Recommended Dietary Allowances - the total daily needs).



Graph 1. RDA for microelement contents in 100g of dry bean grain
RDA za sadržaj mikroelemenata u 100g suhog graha

Data obtained from these studies show that if using local bean variety Bosna, in 100 g of dry grains there are available stocks of magnesium in the amount of 49.6% of RDA, 59.2% RDA of phosphorus, 54.9% RDA of manganese, 39.3% RDA of iron and 64.1% RDA of copper (Graph 1).

The same weight of Darko dry grains provides RDA in the following percentages: 52.6% of magnesium, 39.7% of phosphorus, 79.8% of manganese, 42.2% of iron and 49.2% of copper. 100 g of grains of Igman provides 69.7% of magnesium, 42.8% of phosphorus, 74.4% of manganese, 30.6% of iron and 60.1% of copper RDA.

Conclusion

The studies of dry grains of domestic varieties (Bosnia, Igman and Darko), performed in order to draw attention to their energy and nutritional value, resulted in useful indicators. Recalculation of energy value of these cultivars was significantly lower compared with the data provided by the USDA (2007) (100g of beans is 1393 kJ). For Bosnia cultivar, it is 526.92 kJ or 125.45 Kcal, Darko 532.64 or 126.8 Kcal, and Igman 537.28 kJ or 120.35 Kcal. Yet, it is claimed that domestic bean cultivars belong to nutritious vegetables as 100 g gives more than 25 kcal (105 kJ).

Positive nutritional characteristics refer to mineral contents in dry bean grains examined for the domestic varieties. The results suggest that using these dry beans in the diet, we can meet the RDA for magnesium up to 69.7%, for phosphorus up to 59.2%, for manganese up to 79.8%, for iron up to 42.2% and for copper up to 64.1% (RDA = Recommended Dietary Allowances - total daily needs).

Igman has the highest content of magnesium (207.6750 mg) in 100g of dried beans, Bosna phosphorus (472.4484 mg) and copper (0.5277 mg), and Darko has the highest content of manganese (1.5956 mg) and iron (6.0718 mg).

The results indicate the advantages of local bean selection, which, along with the appropriate grain yields, is a good source of macro and micro nutrients.

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Energetska i nutritivna vrijednost sirovog zrna domaćih sorti graha

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Sažetak

Grah je namirnica velike hranjive vrijednosti. U istoriji ljudske ishrane grah nalazimo vrlo rano u upotrebi, a dostupnost tokom cijele godine omogućava njegovu široku primjenu. Na prostorima Bosne i Hercegovine grah je uobičajena namirnica koja je sastavni dio obroka, posebno u zimskom periodu. Cilj nam je da ovim radom damo doprinos odabiru domaćih sorata graha, ističući energetske i nutritivne vrijednosti sirovog zrna. Ispitivanja u ovom radu su obuhvatila tri domaće sorte graha: Bosna, Darko i Igman kod kojih su određivani sadržaji ugljikohidrata, proteina i masti (energetski sadržaj), te sadržaj minerala (bakar, željezo, fosfor, mangan i magnezijum). Rezultati ispitivanja ukazuju da sadržaj suhe materije i vode nije uslovljen sortnim razlikama, ali sadržaj ukupne masti varira od 0,84% (sorta Bosna) do 1,73% (sorta Darko), a ukupnih šećera od 2,4% (sorta Bosna) do 3,36% (sorta Darko i Igman). Utvrđeni sadržaj proteina je od 21,18% u odnosu na suhu materiju kod sorte Darko do 25,28 % kod sorte Bosna. Sadržaj skroba se kretao od 65,78 % (sorta Igman) do 67,04 % (Bosna). Ispitivane sorte graha sadrže značajne količine mikroelemenata, te se iz 100g sirovog zrna može unijeti u organizam: magnezija do 69,7%, fosfora do 59,2%, mangana do 79,8%, željeza do 42,2% i bakra do 64,1% RDA (Recommended Dietary Allowances - ukupne dnevne potrebe organizma).

Ključne riječi: grah, sirovo zrno, energetski sadržaji, minerali, RDA

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